

1. describe the role of calcium ions on contraction of a muscle fiber

As calcium ions are released from the sarcoplasmic reticulum, they bind to troponin. Troponin will then pull on tropomyosin causing it to move, and allowing the binding sites to be free. The myosin globular heads can now bind to the binding sites forming cross-bridges of actomyosin.

2. Explain the proposed ratchet mechanism or the sliding filament theory for the contraction of myofibrils

- Calcium ions bind to troponin causing tropomyosin to be pulled and moved away from binding sites
- Myosin globular heads bind to the exposed binding sites on tropomyosin
- An actomyosin bridge is formed
- ADP and inorganic phosphate group is released from the head as myosin changes shape. The head bends forward, pulling the actin filament in. this results in shortening of the sarcomere (contraction)
- The shortening of many sarcomeres together causes contraction of a myofibril
- Free ATP will bind to the head and actomyosin bridge is broken
- ATPase on head will be activated and hydrolyse ATP with the help of calcium ions
- Myosin returns to its original shape
- With continued stimulation calcium ions remain in the sarcoplasm and continue contraction, or they are pumped back to the sarcoplasmic reticulum using ATP
- Troponin and tropomyosin return to their original positions
- Muscle fiber is relaxed as contraction is complete

Flowchart of muscle formation

Actin + myosin filament → sarcomere → myofibril → many myofibrils lying parallel to each other → muscle fiber → bundles of muscle fiber being held together by connective tissue → muscle

3. Explain the importance of ATP in the contraction of striated muscles

ATP is used for breaking actomyosin bridges and pumping calcium ions back to the sarcoplasmic reticulum

4. Describe the structures of myosin and actin

- a. Myosin is made of two polypeptide chains twisted together each ending in a globular head. The globular head has ADP + Pi and can act as ATPase
- b. Two chains of actin monomers are joined together. The actin molecules provide binding sites for myosin globular heads. The protein tropomyosin is wrapped around the actin double chains and covers the binding sites in a relaxed state. The protein troponin is also present where calcium ions attach.

5. Explain how the features of slow twitch fibres, shown in the table, are of benefit to an Olympic marathon runner

Slow twitch muscles fibres have a much higher proportion of mitochondria allowing aerobic respiration to take place. Increased amount of myoglobin in these muscle cells allows a greater store of oxygen, allowing aerobic respiration for much longer. The muscles contract slowly and can have sustained contractions, this allows continued exercise to take place without tiring.

- These muscles also have a rich blood supply for a higher glucose demand
- Red in pigment

Myoglobin

Respiratory pigment with one protein chain

So has a higher affinity for oxygen

Only releases oxygen only when all the oxyhaemoglobin has been used up

Fast twitch muscle fibres have a

Lower proportion of mitochondria, hence respiration can occur anaerobically as well. These muscles fatigue quickly. There is a smaller proportion of myoglobin as well, so storage of oxygen is lower. There is a lower blood supply as contraction is rapid, due to this, the muscles are paler in pigment.

- Contain rich glycogen stores that convert glucose for respiration
- Contain high levels of creatine phosphate that can be used to form ATP

6. Compare slow twitch muscle fibres and fast twitch muscle fibres

Feature of fibre	Slow twitch fibre	Fast twitch fibre
Number of mitochondria per fibre	many	Few
Number of myoglobin molecules per fibre	Many	few
Capillary network	Many	few
Contraction	Slow and sustained	Rapid and intense